(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 206 026**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 86107603.2

(22) Date of filing: 04.06.86

(51) Int. Cl.⁴: **F 16 D 3/41**, B 21 B 35/14

(30) Priority: 13.06.85 US 744227

(43) Date of publication of application: 30.12.86
Bulletin 86/52

(84) Designated Contracting States: AT BE CH DE FR GB IT LI LU NL SE

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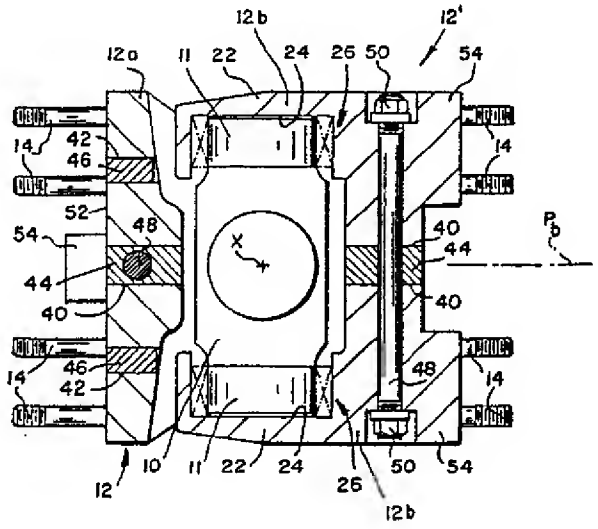
(54) **Split yoke universal joint.**

(57) A high torque universal joint has a cross (10) formed by two mutually perpendicular pairs of coaxial trunnions (11), each pair of trunnions being rotatably received in bearings (26) which in turn are coaxially retained in blind bores (24) in the bearing caps (22) of one of two yokes (12, 12'). The yokes are subdivided into mating half sections (12a, 12b) which each include one of the bearing caps. The mating half sections are separably interconnected (48, 50) and are provided with juxtaposed confronting surfaces (38) lying on opposite sides of first yoke reference planes extending through the universal joint center (X). The mating half sections have end surfaces (52) which are adapted to abut the flanged ends (18) of rotatable elements (20) at second yoke reference planes. The first and second reference planes of each yoke are mutually perpendicular, and first and second key members (44, 54) are located respectively at the first and second reference planes. The restraining forces acting at the first and second yoke reference planes coact during service of the joint to prevent relative movement between the mating yoke half sections.



EP 0 206 026 A1

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improvement in the design of Hooke's or Cardan type universal joints of the type employed in high torque applications such as those typically encountered in rolling mills. As herein employed, the term "high torque" means torques on the order of 1 to 5 million foot pounds and higher.

2. Description of the Prior Art

In the conventional Hooke's or Cardan type universal joint of the type mentioned above, the trunnions of a cross are rotatably supported by bearings retained in the bearing caps of a complimentary pair of yokes. The yokes are in turn connected to rotatable driving or driven elements. Typically, in a horizontal rolling mill, one yoke is attached to one end of a spindle, and the other yoke is attached either to the output shaft of a drive motor, or to one of the work rolls.

In many cases, the yokes are cast as unitary pieces, and through bores are provided in the bearing caps. The unitary yokes are first assembled onto the trunnions, and then the bearings are inserted through the through bores. Finally, the through bores are closed by removable side covers. It has been found, however, that for high torque applications of the type herein under consideration, the structural stiffness of the bearing caps is often unacceptably compromised by the through bores.

In an attempt at overcoming this difficulty, the conventional through bores in the bearing caps have been eliminated in favor of blind bores. By employing blind bores, the structural stiffness of the bearing caps is significantly increased as compared with the prior through bore designs. However, in order to permit yokes with blind bores to be assembled onto the trunnions of the cross, the

yokes must be split into separate mating half sections, each including one of the bearing caps. Unfortunately, the splitting of the yokes has created other problems caused by the tendency of the half sections to shift in relation to each other while the joint is in service. This relative movement subjects the bearing assemblies to unbalanced loading, causing accelerated wear. Relative movement between the mating half sections can also loosen the bolts or studs used to connect the yokes to the flanged ends of the driving or driven elements, thus causing failure of the joints.

SUMMARY OF THE PRESENT INVENTION

A primary objective of the present invention is to provide an improved means of reliably maintaining bearing alignment between the separate mating half sections while the universal joint is in service. A companion objective of the present invention is to prevent loosening of the bolts or studs used to connect the yokes to the flanged ends of the driving and driven elements.

In accordance with the present invention, the mating half sections of each yoke are separably interconnected, and are provided with juxtaposed confronting surfaces lying on opposite sides of a first yoke reference plane passing through the center of the joint. The mating half sections of each yoke abut the flanged ends of the associated driving or driven elements at second yoke reference planes which are perpendicular to the respective first yoke reference planes. First and second key members are located respectively at the first and second yoke reference planes.

In a preferred embodiment to be hereinafter described in more detail, the juxtaposed confronting surfaces at the first yoke reference plane are essentially flat and parallel and are provided with confronting centrally located keyways. The first key members are received in the confronting keyways, and have load carrying side surfaces which are

tightly fitted between and which cooperate with adjacent side surfaces of the confronting keyways. The second key members at the second yoke reference planes are preferably although not necessarily formed integrally with and protrude rearwardly from the mating half sections into recesses in the flanged ends of the associated driving or driven element. The restraining forces acting at the first and second yoke reference planes coact during service of the joint to prevent relative movement between the mating yoke half sections, thereby maintaining critical bearing alignment while at the same time preventing loosening of the bolts or studs used to detachably connect the yokes to the driving or driven elements.

The means for separably interconnecting the mating yoke half sections preferably includes one or more tie bolts or other like connecting elements extending through the mating half sections in directions perpendicular to the respective first yoke reference planes.

The juxtaposed surfaces of the mating yoke half sections may additionally include confronting channels on opposite sides of the centrally located keyways. Spacer blocks are received in the confronting channels. The spacer blocks have oppositely facing surfaces which cooperate with the bottoms of the channels to laterally locate the mating yoke half sections with respect to each other on opposite sides of the respective first yoke reference planes.

The invention will now be described in greater detail with reference to the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view with portions broken away of a high torque rolling mill universal joint in accordance with the present invention;

Figure 2 is a perspective partially exploded view of the universal joint shown in Figure 1;

Figure 3 is a sectional view taken along line 3-3 of Figure 1;

Figure 4 is a sectional view taken along line 4-4 of Figure 3; and

Figure 5 is an enlarged partial sectional view of one of the bearing caps with a trunnion and bearing assembly received therein.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENT

Referring now to the drawings, a preferred embodiment of a high torque universal joint in accordance with the present invention is shown including a cross 10 formed by two mutually perpendicular pairs of coaxial trunnions 11, with a pair of yokes 12,12' mounted thereon. The yokes have rearwardly protruding threaded studs indicated typically at 14 which cooperate with nuts 16 to attach the yokes to flanges 18 on rotatable elements 20. As previously indicated, in rolling mill applications, the rotatable elements will typically comprise spindles, work rolls, drive motor output shafts, etc. The yokes 12,12' are respectively subdivided into mating half sections 12a,12a and 12b,12b. Each half section includes a base portion with an integral forwardly protruding bearing cap 22 having an inwardly opening blind bore 24. Bearing assemblies 26 are contained in the blind bores 24. The mating half sections of each yoke 12,12' are adapted for assembly onto a respective pair of the trunnions 11, with each trunnion being journalled for rotation in a respective one of the bearing assemblies 26.

As can be best seen in Figure 5, each bearing assembly 26 preferably includes an inner race 28, an outer race 30, with one or more sets of rollers 32, 34 interposed therebetween. A non-metallic thrust washer 36 is interposed between the end of each trunnion 11 and the bottom of each blind bore 24.

The thus assembled mating half sections 12a,12a and 12b,12b have juxtaposed confronting surfaces 38. With reference in particular to Figure 3, it will be seen that the juxtaposed surfaces 38 of mating half sections 12b,12b

lie on opposite sides of a first yoke reference plane P_b, whereas the juxtaposed confronting surfaces 38 of mating half sections 12a,12a lie on opposite sides of another first yoke reference plane P_a which is perpendicular to plane P_b. Both first yoke reference planes P_a, P_b pass through the universal joint center "x".

The juxtaposed surfaces 38 are machined to provide confronting centrally located keyways 40. Additional confronting channels 42 are located on opposite sides of the keyways 40. First keys 44 extend across the first reference planes P_a, P_b and are received in the confronting keyways 40. Spacer blocks 46 also lie on the reference planes P_a, P_b and are received in the confronting channels 42.

The first keys 44 have side surfaces which are tightly fitted between and which cooperate with the adjacent side surfaces of their respective keyways 40 to oppose movement of the mating half sections 12a,12a and 12b,12b relative to each other in directions parallel to their respective first yoke reference planes P_a, P_b.

After being assembled onto the trunnions, the mating yoke half sections 12a,12a and 12b,12b are preferably separably interconnected by connecting means comprising tie rods 48 extending therethrough and, in the embodiment herein disclosed, through the first keys 44 in directions perpendicular to the respective first yoke reference planes P_a,P_b. In other words, the tie rod interconnecting the mating half sections 12a,12a of yoke 12 is perpendicular to first yoke reference plane Pa, and the tie rod interconnecting the mating half sections 12b,12b of yoke 12' is perpendicular to reference plane P_b. Nuts 50 are threaded onto the ends of the tie rods to complete the assembly of each yoke.

While only one tie rod is shown connecting each pair of half sections, it will be understood that multiple

tie rods may be employed, and that the single or multiple tie rods need not necessarily extend through the keys 44.

The spacer blocks 46 have oppositely facing surfaces which cooperate with the bottoms of the channels 42 to laterally locate the mating half sections with respect to each other on opposite sides of their respective first yoke reference planes P_a, P_b. The spacer blocks insure that the bottoms of the blind bores 24 are located concentrically with respect to the joint center x. The thrust washers 36 provide bearing surfaces for the oscillation movement of the cross and cooperate with the bottoms of the blind bores in locating the cross concentrically with the joint center x.

It will be understood that the spacer blocks 46 are particularly useful when the mating half sections 12a,12a and 12b,12b have been formed by cutting a unitary casting into two pieces. However, where the half sections are separately cast, the spacer blocks may be omitted. Also, the keys 44 need not be centrally located, and in some cases, for example when the half sections are separately cast, it may be desirable to substitute a male/female interengagement in place of the removable keys 44.

The thus assembled and interconnected mating yoke half sections 12a,12a and 12b,12b are removably mounted on the end flanges 18 of the rotatable elements 20 by a mounting means comprising the previously described studs 14 and nuts 16. When thus mounted, the end surfaces 52 of the yoke half sections abut the flanges 18 of the rotatable elements at second yoke reference planes P_c,P_d. The reference planes P_a,P_c of yoke 12 are mutually perpendicular, as are the reference planes P_b,P_d of yoke 12'.

In the embodiment herein disclosed, second keys 54 are formed integrally on each of the yoke half sections. The second keys 54 protrude rearwardly from the

yoke end surfaces 52 into recesses in the end flanges 18 to thereby mechanically couple the yokes 12, 12' to the rotatable elements 20.

In certain cases, it might be desirable to form the second keys integrally with the end flanges 18, and to have them protrude into recesses in the yoke half sections. Alternatively, removable keys might be positioned to extend across the second yoke reference planes P_c,P_d into confronting recesses in both the yoke half sections and their respective end flanges 18.

The above described arrangement provides a unique and highly effective means of preventing relative movement between the mating half sections of each yoke while the universal joint is in service, which in turn insures that the trunnion bearings 26 remain coaxially aligned and that the nuts 16 on the studs 14 do not loosen. More particularly, there is an important coaction between the first keys 44 located at the first yoke reference planes P_a,P_b, and the abutting surfaces between the yoke base surfaces 52 and the flanges 18 at the second yoke reference planes P_c,P_d. The former effectively opposes relative movement of the mating yoke half sections relative to each other in directions parallel to their respective first yoke reference planes P_a,P_b, whereas the latter opposes relative twisting of the mating yoke half sections across the second yoke reference planes P_c,P_d. The net result is an axially and radially compact universal joint capable of operating reliably for extended periods of time under high torque conditions.

I claim:

1. A high torque universal joint for providing a drive connection between the flanged ends of two rotatable elements, said joint comprising:

a cross formed by two mutually perpendicular pairs of coaxially aligned trunnions;

a pair of yokes, each yoke being subdivided into separate mating half sections, each half section including a base portion with an integral forwardly protruding bearing cap having a blind bore formed therein;

bearings contained in said blind bores, the mating half sections of each yoke being adapted for assembly onto a pair of said trunnions, with each trunnion being journalled for rotation in one of said bearings, and with the base portions of the thus assembled mating half sections having juxtaposed surfaces located on opposite sides of a first yoke reference plane passing through the center of the joint;

first interengagement means extending across said first yoke reference planes for opposing relative movement of the thus assembled mating half sections in directions parallel to said first yoke reference planes;

mounting for detachably mounting the thus assembled mating half sections to a respective one of said flanged ends, said mating half sections and said flanged ends having mutually abutting surfaces lying on second yoke reference planes which are perpendicular to the respective first yoke reference planes; and

second interengagement means extending across said second yoke reference planes for mechanically coupling the thus assembled, interconnected and mounted mating half sections to their respective flanged ends.

2. The universal joint of claim 1 further comprising connecting means for separably interconnecting the thus assembled mating half sections.

3. The universal joint of claim 2 wherein said connecting means extend through said mating half sections in directions perpendicular to their respective first yoke reference planes.

4. The universal joint of claim 3 wherein said connecting means extend through said first interengagement means.

5. The universal joint of claim 3 wherein said first interengagement means comprises at least one first key extending into complimentary opposed keyways in said juxtaposed surfaces.

6. The universal joint of claim 5 wherein said first keys and said complimentary opposed keyways are centrally located, and wherein said connecting means extend through said first keys.

7. The universal joint of claim 6 further comprising confronting channels in said juxtaposed surfaces, and spacer elements received in said channels, said spacer elements having oppositely facing surfaces cooperating with the bottoms of said channels to laterally locate said mating yoke half sections with respect to each other on opposite sides of their respective first yoke reference planes.

8. The universal joint of claim 1 wherein said second interengagement means comprises second keys formed integrally with said half sections and protruding rearwardly therefrom into recesses in said flanges ends.

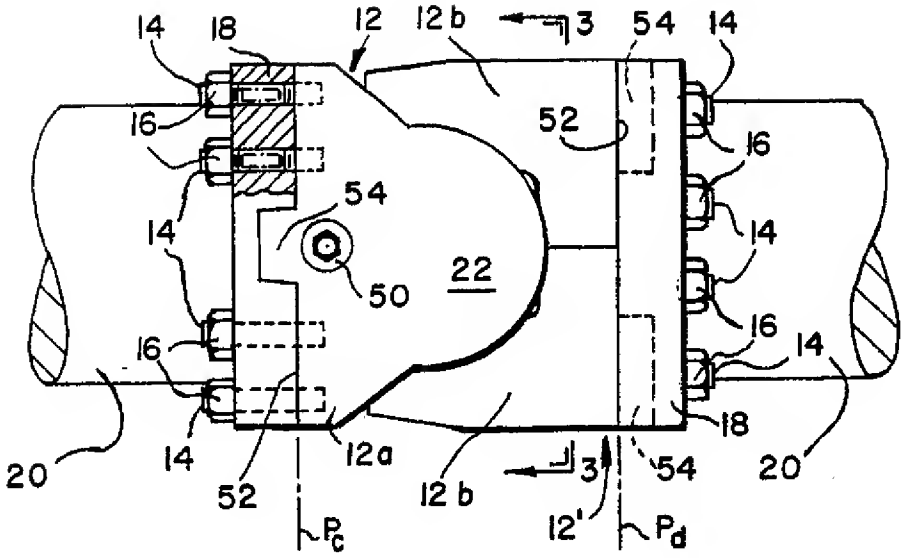
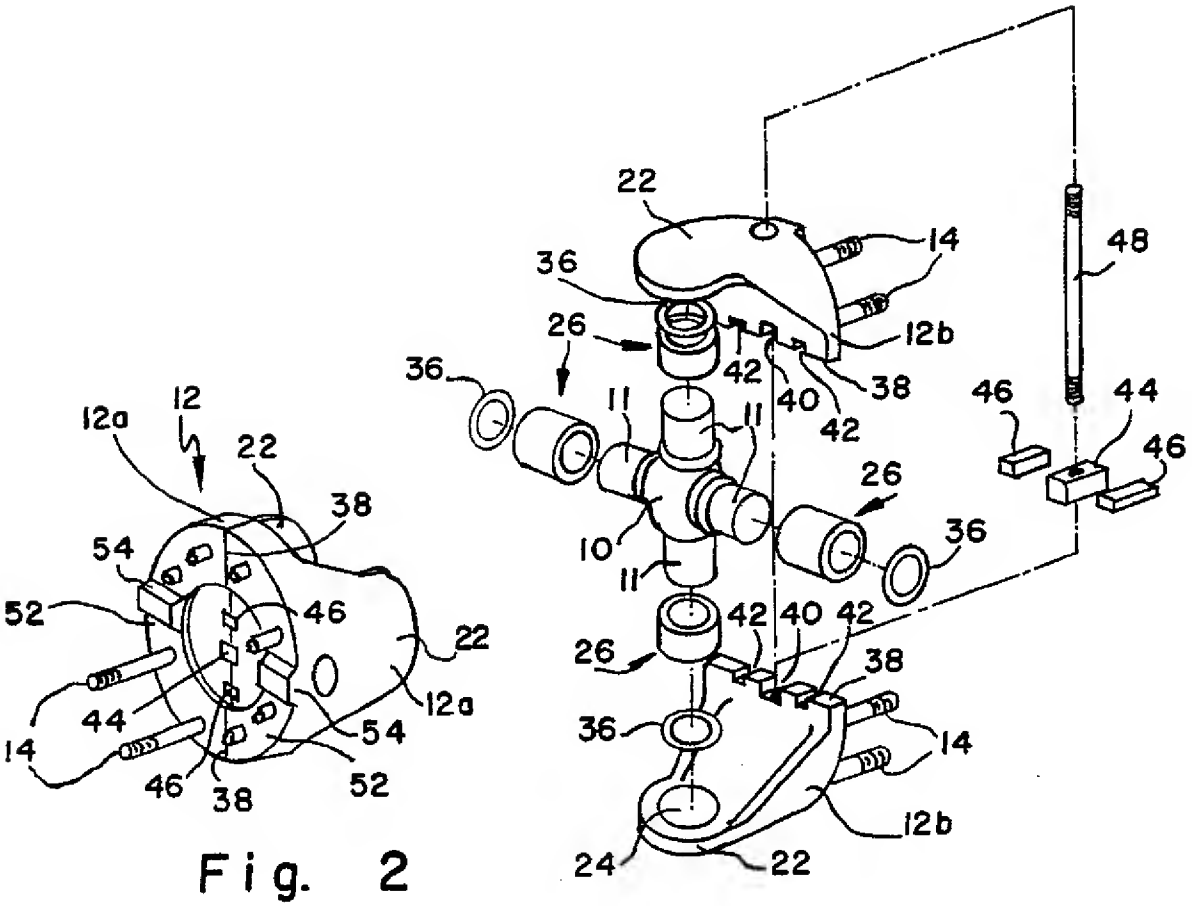

14
18
12
12b
3
54
14
16
52
16
54
14
14
22
50
16
16
14
20
14
52
12a
12b
3
54
20
18
P_c
12'
P_d

Fig. 1


22
14
48
36
12b
26
42
38
36
40
42
46
44
46
11
11
26
10
36
11
42
40
42
26
38
36
14
12b
24
22
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12a
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38
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52
46
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12a
44
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14
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38
52

Fig. 2

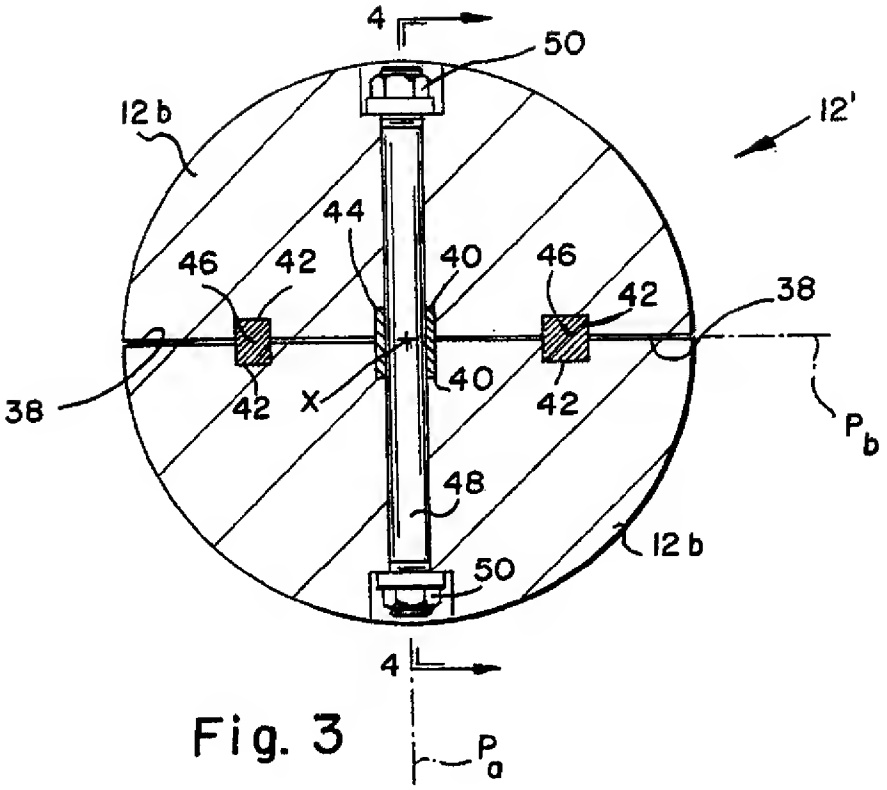
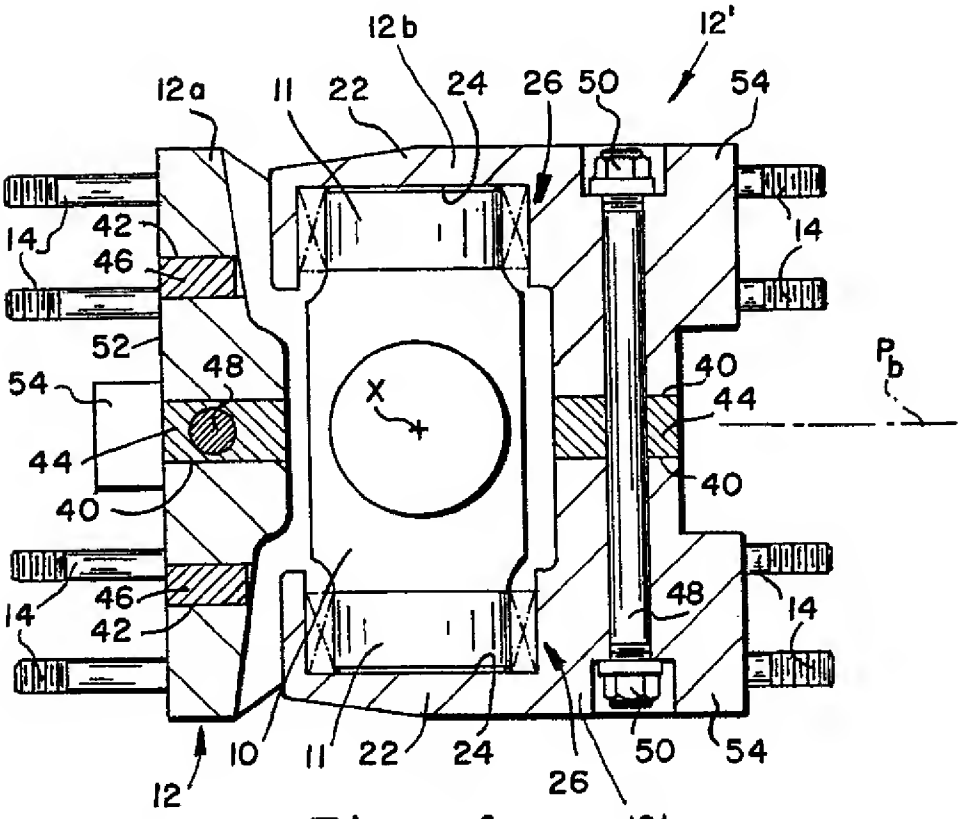

4
50
12b
12'
44
46
42
40
46
42
38
38
42
X
40
42
P_b
48
12b
50
4
P_a

Fig. 3


12b
12'
12a
11
22
24
26
50
54
14
42
46
52
54
48
44
40
14
42
46
X
P_b
40
44
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48
14
14
10
11
22
24
26
50
54
12
12b

Fig. 4

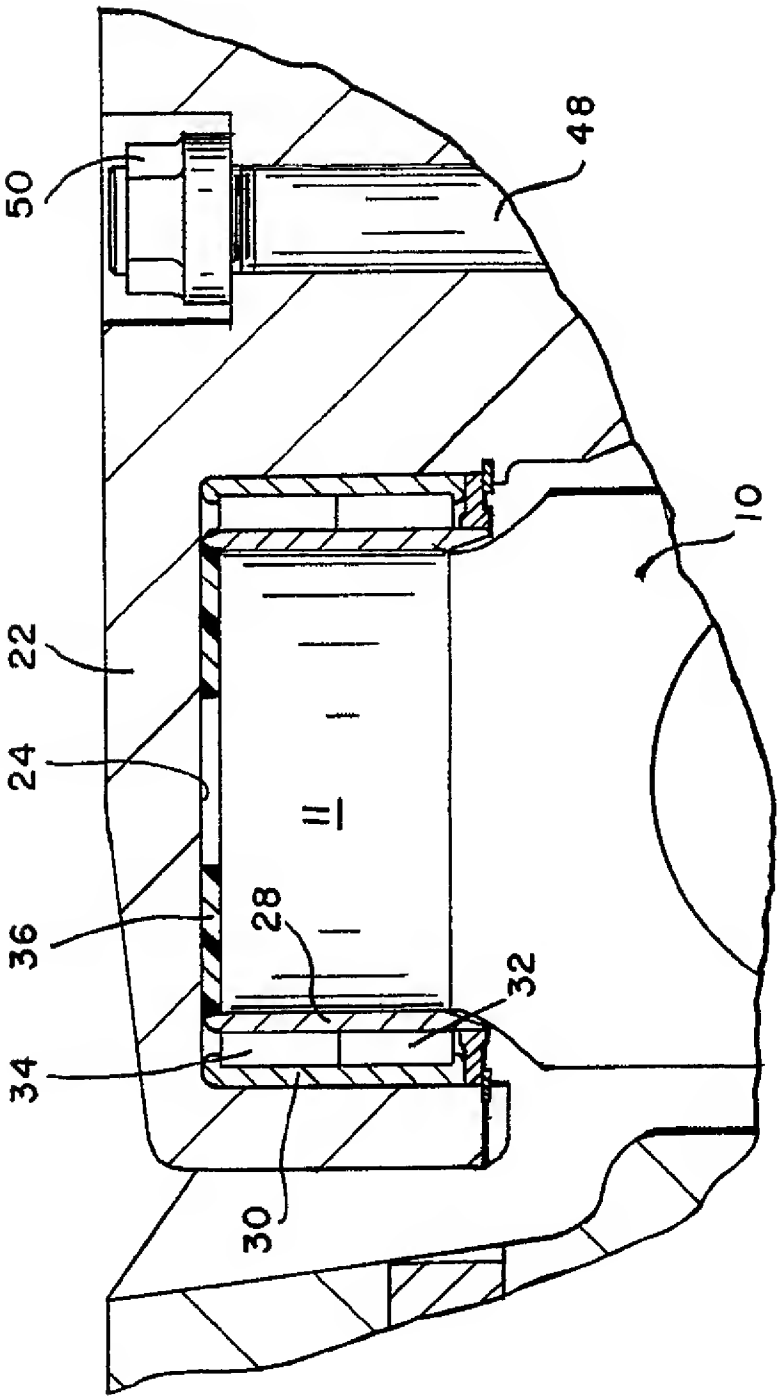

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

0206026
Application number

EP 86 10 7603

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	FR-A-2 190 210 (PAULSTRA) * Pages 4,5; figure 3 *	1-4,7, 8	F 16 D 3/41 B 21 B 35/14
Y	DE-C- 624 185 (MECHANICS UNIVERSAL) * Whole document *	1-4,7, 8	
Y	FR-A-2 487 933 (SEMIAC) * Whole document *	2-4	
A		1	
Y	GB-A-1 552 272 (KOYO SEIKO) * Page 2; figures 3-5 *	7	
A	GB-A- 709 298 (BISHOP)		TECHNICAL FIELDS SEARCHED (Int. Cl.4) F 16 D 3/00 B 21 B
A	FR-A-1 571 474 (USINES RENAULT)		
A	US-A-3 204 428 (STOKELY)		
A	US-A-2 698 527 (ANDERSON)		

-/-

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-09-1986	BALDWIN D.R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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EUROPEAN SEARCH REPORT

0206026
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	FR-A-2 165 014 (GLAENZER SPICER)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

The present search report has been drawn up for all claims

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THE HAGUE	12-09-1986	BALDWIN D.R.

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